Supporting Information

Ionic liquid/ether-plasticized quasi-solid-state electrolyte for long-life lithium−oxygen cells

Chongjia Zhu,[a] Qiushi Sun,[a] Jian Xie,[*a,b] Yuan Jin,[c] Kangyan Wang,[c] Zhen Chen,[d] Jian Tu[d]

Gaoshao Cao[*b] and Xinbing Zhao[a,b]

[a] *State Key Laboratory of Silicon Materials, School of Materials Science and Engineering, Zhejiang University, Hangzhou 310027, P. R. China. E-mail: xiejian1977@zju.edu.cn; gscao@zju.edu.cn; Fax: +86-571-87952181; Tel: +86-571-87951451*

[b] *Key Laboratory of Advanced Materials and Applications for Batteries of Zhejiang Province, Hangzhou 310027, P. R. China*

[c] *Zotye Automobile Corporation Limited, Hangzhou 310018, P. R. China*

[d] *LI-FUN Technology Corporation Limited, Zhuzhou 412000, P. R. China*

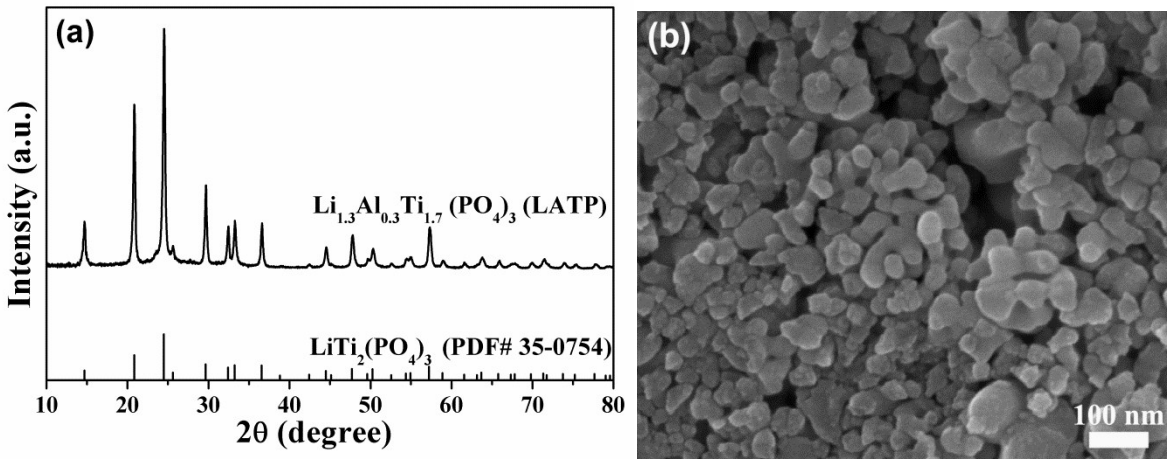


Fig. S1. (a) XRD patterns and (b) SEM image of LATP powder.

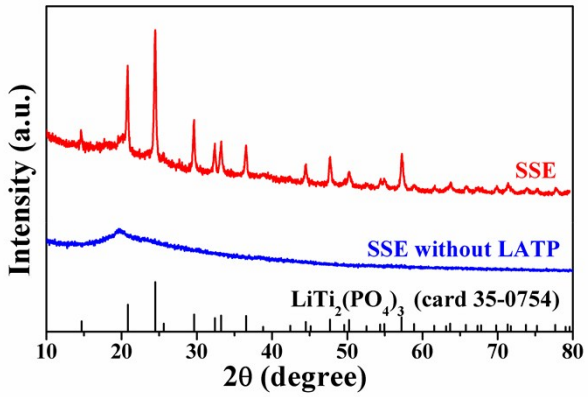


Fig. S2. XRD patterns of the dry solid membrane.

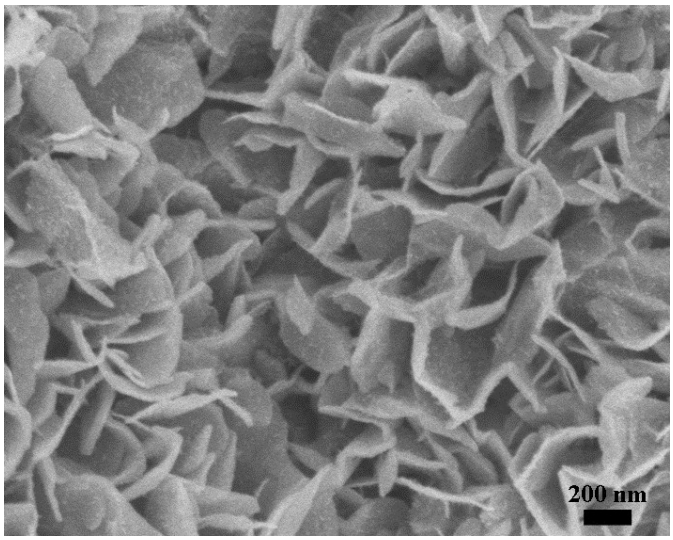
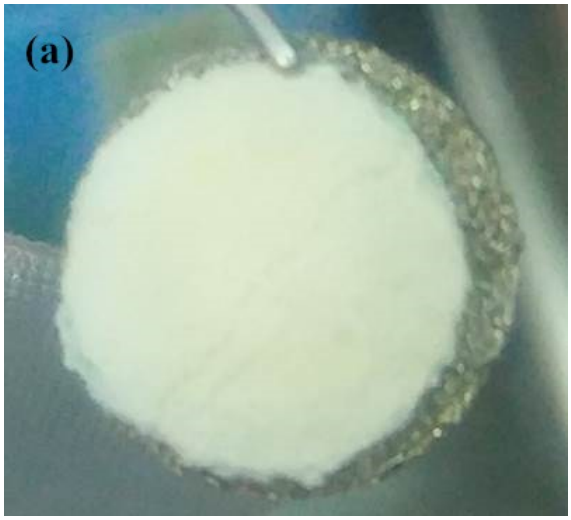


Fig. S3. SEM image of IrO_2/MnO_2 on carbon cloth.



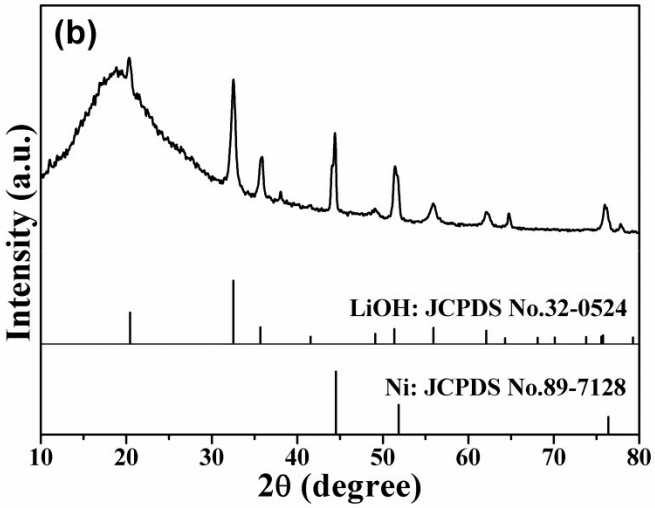


Fig. S4. (a) Photo and (b) XRD patterns of the Li anode after 90 cycles using QSSE with the TEGDME plasticizer. The Li foil was supported by Ni foam during the electrochemical cycling.

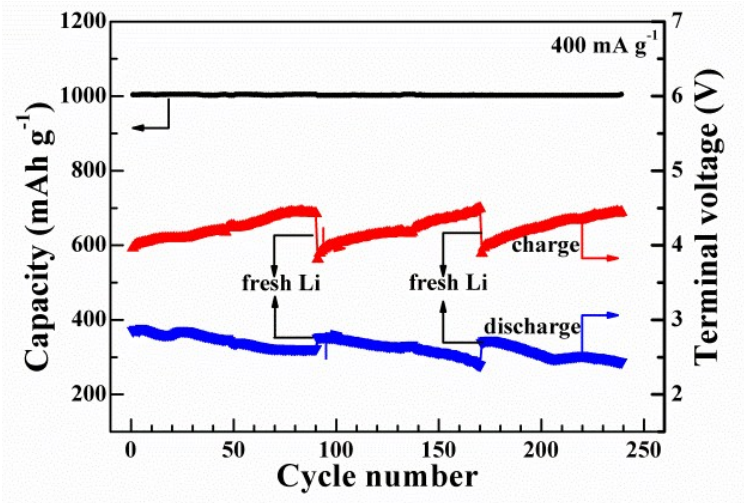
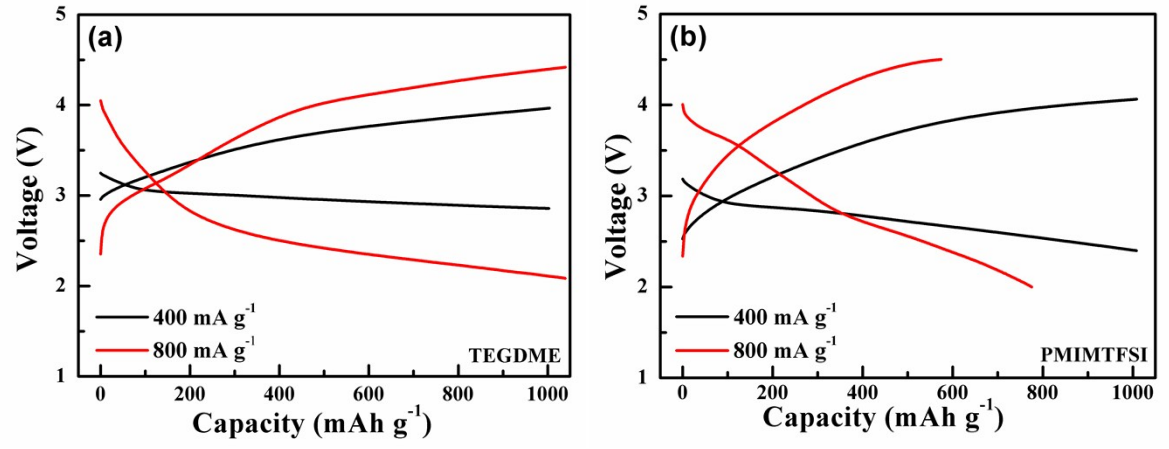


Fig. S5. Cycling performance of Li−O_2 cell with the QSSE plasticized by TEGDME. During the cycling, the failed Li anode was replaced by the fresh one and the cell was re-fabricated.



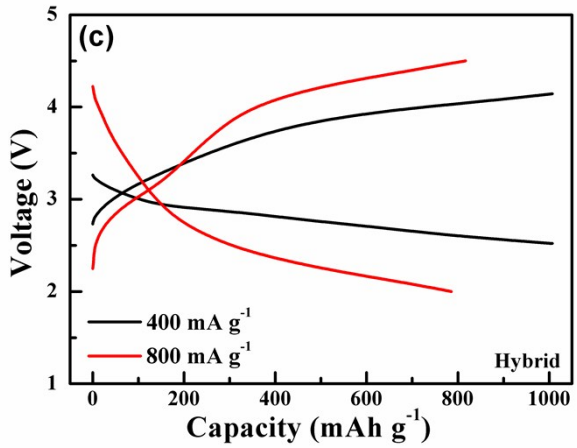


Fig. S6. Rate capability of the cells with different QSSEs.

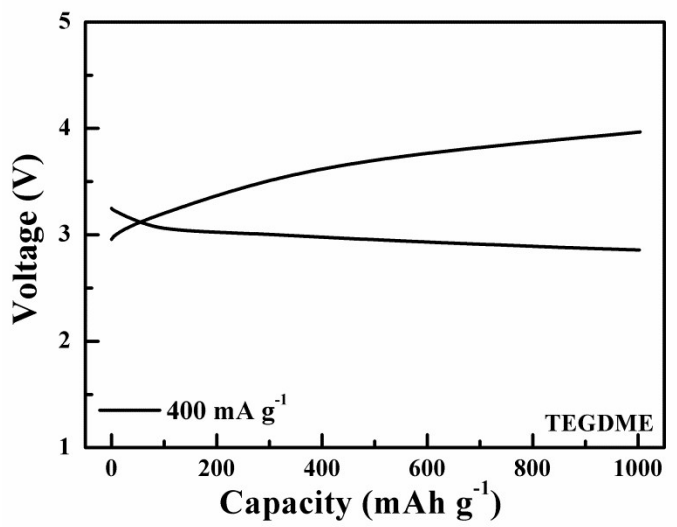


Fig. S7. Voltage profiles of Li−O_2 cell with the TEGDME-plasticized QSSE in the initial cycle.

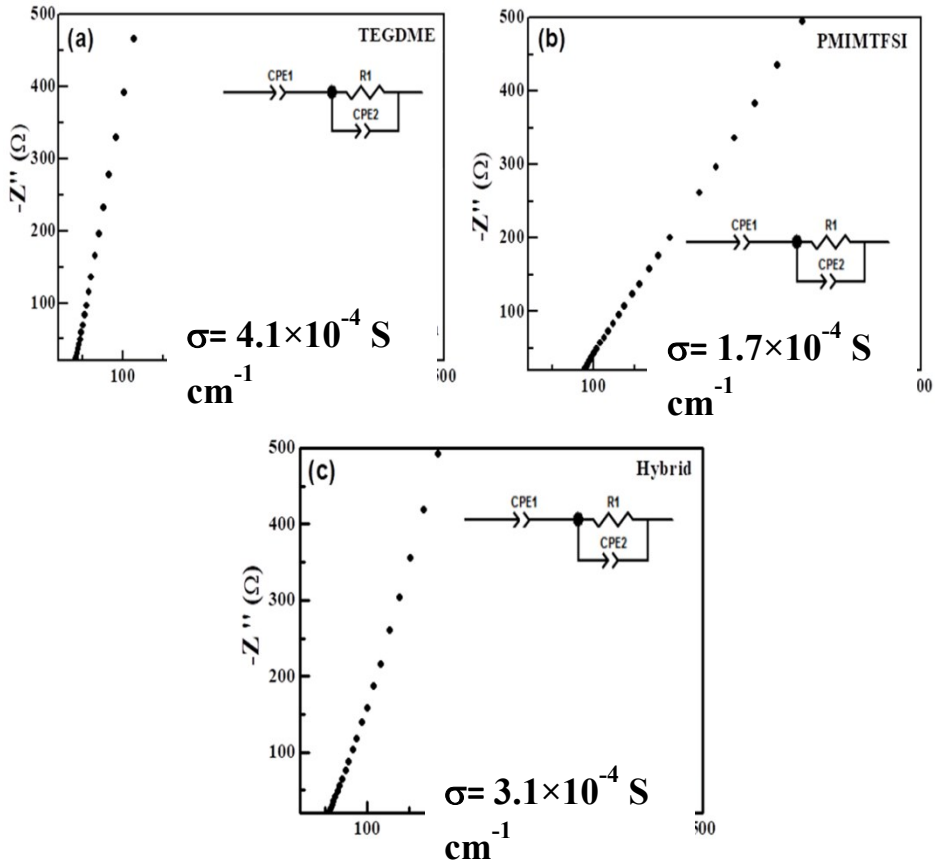


Fig. S8. Nyquist plot of the QSSE plasticized by (a) TEGDME, (b) PMIMTFSI, and (c) TEGDME/PMIMTFSI hybrid sandwiched between two stainless steel plates. The ionic conductivity (σ) of the QSSE was calculated from the equation of $\sigma = d/(R \times A)$, where d, R, and A are the thickness, resistance and area, respectively, of the QSSE membrane. The measurement was conducted at room temperature.

Fig. S9. Photo of Li anode protected by PI film for XRD characterization.

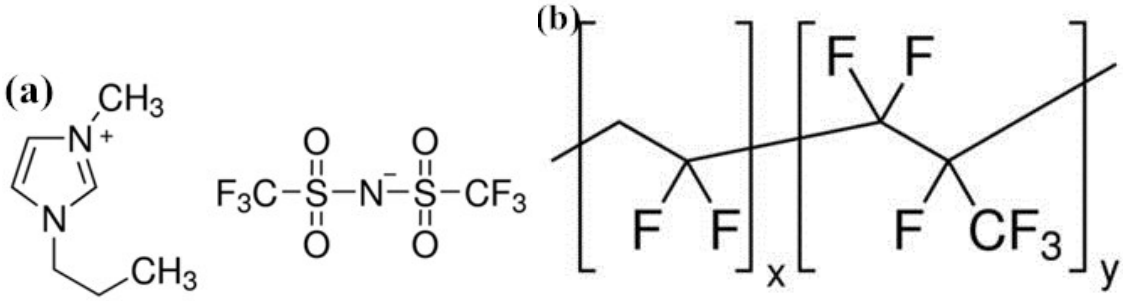


Fig. S10. Structural formulas of (a) PMIMTFSI and (b) P(VDF-HFP).

Table S1. Comparison of cycling performance of solid-state Li−O_2 cells.

Sample (matrix)	Current density	Capacity limitation	Cycle number	Ref.
PVDF-HFP/PPC/LATP	**400mA $g_{catalyst}^{-1}$**	**1000mA h $g_{catalyst}^{-1}$**	**196**	**This work**
ETPTA/HMPP/PVDF-HFP	100 mA $g_{catalyst}^{-1}$	500 mA h $g_{catalyst}^{-1}$	28	1
P(PEGMA)/MTA/Silica	100mAg_{MWCNT}^{-1}	500 mA h g_{MWCNT}^{-1}	125	2
PVDF-HFP	50 mA $g_{catalyst}^{-1}$	500 mA h $g_{catalyst}^{-1}$	50	3
ETPTA/HMPP/GF	250 mA g_{CNT}^{-1}	500 mA h g_{CNT}^{-1}	54	4
PMS/PE	250 mA $g_{catalyst}^{-1}$	1000 mA h $g_{catalyst}^{-1}$	100	5
Fumed silica/PYR14TFSI	100 mA $g_{catalyst}^{-1}$	1000 mA h $g_{catalyst}^{-1}$	100	6

References

1 L. Xiao, E. W. Li, J. Y. Yi, W. Meng, B. H. Deng and J. P. Liu, *Rare Met.*, 2018, **37**, 527−535.

2 S. M. Cho, J. Shim, S. H. Cho, J. Kim, B. D. Son, J. C. Lee and W. Y. Yoon, *ACS Appl. Mater. Interfaces*,

2018, **10**, 15634−15641.

3 J. Q. Zhang, B. Sun, X. Q. Xie, K. Kretschmer and G. X. Wang, *Electrochim. Acta*, 2015, **183**, 56−62.

4 A. Chamaani, M. Safa, N. Chawla and B. El-Zahab, *ACS Appl. Mater. Interfaces*, 2017, **9**, 33819−33826.

5 J. Yi and H. S. Zhou, *ChemSusChem*, 2016, **9**, 2391–2396.

6 J. Y. Peng, J. Huang, W. J. Li, Y. Wang, Y. Q. Yu, Y. S. Hu, L. Q. Chen and H. Li, *Chin. Phys. B*, 2018, **27**, 078201.